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A REPORT ON WATER SUPPLY AND POLLUTION ABATEMENT BENEFITS. TWELVEPOLE CREEK BASIN, WEST VIRGINIA

PUBLIC HEALTH SERVICE
CHARLOTTESVILLE, VIRGINIA

PREPARED FOR
ARMY ENGINEER DISTRICT
HUNTINGTON, WEST VIRGINIA

JULY 1961

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A REPORT ON WATER SUPPLY AND POLLUTION ABATEMENT BENEFITS

TWELVEPOLE CREEK BASIN

West Virginia

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This report contains the findings of the Public Health Service investigation and information concerning water supplies, pollution sources, and general water quality in Twelvepole Creek Basin, West Virginia as obtained in a field investigation. The Twelvepole Creek Basin is described in terms of population, geography, and industry. Sources of waste are domestic and acid mine drainage. Surface water is evaluated, and ground water is analyzed. Reservoir sites for proposed water storage are discussed with the consideration of flow augmentation to determine the most beneficial and feasible plan for the development and control of the water resources of the basin.

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INVESTIGATION OF

TWELVEPOLE CREEK BASIN

Report on Benefits to Water Supply and Pollution Abatement from Low-Flow Augmentation on the Twelvepole Creek and Tributaries

Prepared at the request of and in cooperation with
the District Engineer, Huntington District,
Corps of Engineers, U. S. Army

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of State Services
Division of Water Supply and Pollution Control

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Huntington Water Corporation

Catlettsburg, Kenova and Ceredo Water
Company, Inc.

Local city officials and water treatment
plant operators

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INTRODUCTION

The District Engineer, Corps of Engineers, Huntington District, requested by letter dated November 21, 1960, that the Public Health Service make a preliminary study of water supply and pollution abatement benefits which might accrue from proposed reservoirs providing low-flow augmentation in Twelvepole Creek Basin, West Virginia. The request was in accordance with the Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare to provide assistance in implementing the Water Supply Act of 1958 (Title III, Public Law 500, 85th Congress).

This report contains the findings of the Public Health Service investigation and information concerning water supplies, pollution sources, and general water quality in Twelvepole Creek Basin as obtained in a field investigation, April 11 to April 15, 1961.

SUMMARY AND CONCLUSIONS

1. Twelvepole Creek Basin, located near the metropolitan area of Huntington, West Virginia, is not developed industrially or commercially.

2. The West Virginia water pollution control agency is requiring secondary treatment of wastes discharged into Basin waters. Wayne, the only community discharging wastes from a municipal system, has been formally notified of this requirement.

3. There are no industrial water uses within the Basin and the present trend of small commercial and residential development will probably continue.

4. Ground water quality within the Basin is, in general, moderately hard, and contains high dissolved solids and significant amounts of iron and manganese.

5. Surface water in the Basin contains low hardness and alkalinity, slight acidity, and significant amounts of iron and manganese.

6. Both ground and surface waters in the Basin are of satisfactory quality for use as raw water sources for domestic supplies.

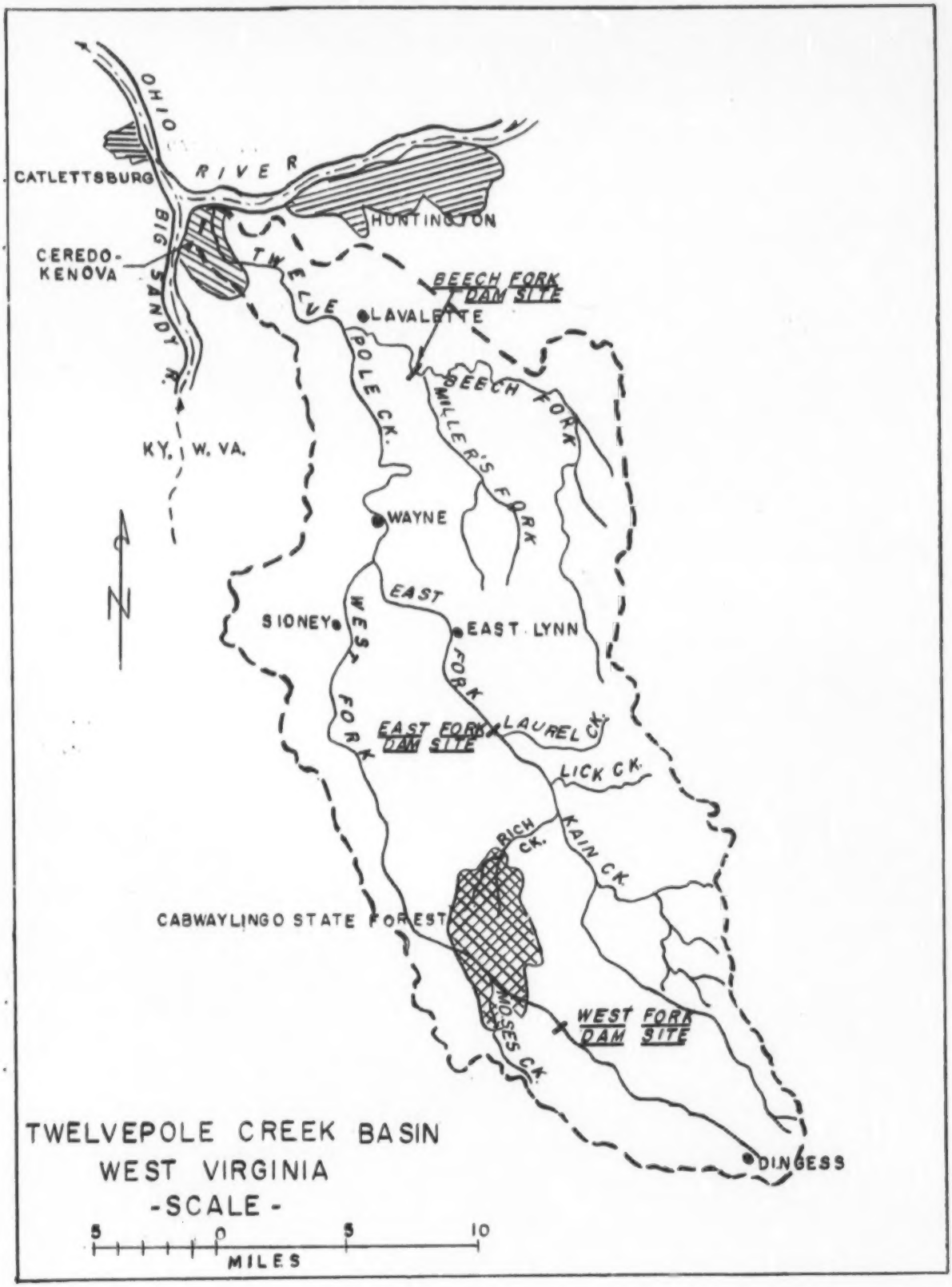
7. Under natural low-flow conditions, surface water quantities are inadequate for projected water supply needs.

8. Ground water is abundant and can meet the needs of the smaller communities; however, because of relatively low well yields and the size of well fields required, large municipalities such as Huntington could not economically develop a ground water source.

9. Wayne is the only community within the Basin utilizing surface waters as a source of water supply, although Huntington has expressed an interest in the possibility of using Twelvepole Creek as a raw water source.

10. Wayne, Ceredo, Kenova and Huntington, West Virginia, and Catlettsburg, Kentucky, were considered for possible water supply benefits from the proposed Federal project. The investigation revealed that Wayne would receive the only monetary benefit ($8,330 annually), but such benefit will not begin until about 1990 when the projected water needs will exceed capabilities of present development.

11. Even with secondary treatment at Wayne, 1.5 cfs of dilution water would be required to maintain desirable stream conditions. Additional treatment beyond secondary could be provided in lieu of dilution water. It is not anticipated that such treatment will be required since the cost would impose an undue financial burden on the community. The estimated annual value of the dilution water as measured by the cost of additional facilities is estimated to be $4,300.


OHIO RIVER
CATLETTSBURG
HUNTINGTON
CEREDO-KENOVA
BIG SANDY R.
KY. | W. VA.
TWELVE POLE CK.
BEECH FORK DAM SITE
LAVALETTE
BEECH FORK
MILLER'S FORK
WAYNE
EAST
WEST FORK
SIDNEY
EAST LYNN
FORK
EAST FORK DAM SITE
LAUREL CK.
LICK CK.
RICH CK.
KAIN CK.
CABWAYLINGO STATE FOREST
MOSES CK.
WEST FORK DAM SITE
DINGESS
TWELVEPOLE CREEK BASIN
WEST VIRGINIA
-SCALE-
5 0 5 10
MILES

DESCRIPTION

THE AREA

Twelvepole Creek Basin is located in southwestern West Virginia, immediately south of Huntington. The majority of the Basin lies in Wayne County with small portions in Cabell, Lincoln, Logan, and Mingo Counties. Twelvepole Creek is formed by the confluence of East Fork and West Fork immediately upstream from the Town of Wayne. From this point, the stream flows in a northeasterly direction 32.5 miles to discharge into the Ohio River near Ceredo, West Virginia.

The Basin has an area of approximately 441 square miles, including 172 square miles in the East Fork drainage area and 116 square miles in the West Fork drainage area. The terrain is mountainous, characterized by steep valleys in the upper reaches of the tributary streams.

Cabwaylingo State Forest lies in the West Fork sub-basin, and covers an area of 8,126 acres (12.7 square miles). The Forest provides recreational activities such as picnicking, camping, fishing, and hunting.

HYDRAULICS

The U. S. Geological Survey has a stream gaging station located at Wayne, West Virginia, with records dating back to 1915. According to these records, the average flow in the stream at Wayne is 326 cfs,

while the maximum and minimum recorded flows are 11,900 cfs and zero respectively.

POPULATION AND INDUSTRIAL DATA

Wayne and Ceredo, West Virginia, are the only incorporated communities located within Twelvepole Creek Basin. The Huntington metropolitan area and Kenova, West Virginia, although outside the Basin, are situated adjacent to the mouth of the creek and account for a portion of the Basin's population. Table 1 lists population data for these communities.

TABLE 1

Population Data

Year	Wayne	Ceredo	Huntington	Kenova	State of West Virginia
1930	675	1,164	75,572	3,680	1,729,205
1940	801	1,212	78,836	3,902	1,901,974
% Change 1930-1940	+ 18.7	+ 19.6	+ 4.3	+ 6.0	+ 10.0
1950	1,257	1,399	86,353	4,320	2,005,552
% Change 1940-1950	+ 57.0	+ 15.4	+ 9.5	+ 10.7	+ 5.4
1960	1,274	1,387	83,627	4,577	1,860,421
% Change 1950-1960	+ 1.3	- 0.9	- 3.2	+ 5.9	- 7.2

There are no major industrial or commercial activities within the Basin and, at present, coal mining is limited to only four active mines. Some natural gas wells exist, but offer little economic benefit to the local population. The greatest economic potential appears to be in the lower basin area adjacent to the industrialized areas of Huntington and Kenova.

Transportation facilities include U. S. Highway 52 serving the Basin north and south, and State Highway 37 serving the Basin east and west. The Norfolk and Western Railway follows Twelvepole Creek from its mouth to East Lynn on East Fork. Tri-State Airport (serving the Huntington, West Virginia, and Ashland, Kentucky, area) is located in the lower Basin south of Ceredo.

WATER RESOURCES

Wayne and Ceredo have the only municipal water systems within Twelvepole Creek Basin. Wayne obtains its raw water supply from Twelvepole Creek and serves approximately 1,800 persons about 72,000 gallons per day. Ceredo obtains its water from three drilled wells and furnishes about 180,000 gallons per day to approximately 3,000 customers.

Individual dwellings in the Basin obtain their water supply from dug or drilled wells which, in general, contain high hardness and iron concentrations. Many residents employ home water-softening units to reduce the hardness.

Low-level dams exist on Twelvepole Creek at Wayne and Dickson (unincorporated community). The dam at Wayne was constructed to provide the Town with raw water storage. Although these dams form only small pools contained within the stream banks, area residents use the pools for boating and other water recreational activities.

There are no known industrial uses of water in the Basin.

SOURCES OF WASTE DISCHARGES

The principal sources of waste discharges are: (1) domestic sewage from the Town of Wayne, (2) scattered discharges of domestic waste and garbage from individual dwellings located along the banks of the streams, and (3) acid-mine drainage.

The West Virginia Department of Natural Resources, Division of Water Resources, has responsibility for control of water pollution within the State. The agency has recently issued official notice to the Town of Wayne that steps must be taken to provide secondary treatment of wastes with chlorination of the plant effluent. Wayne has sewerage facilities serving approximately 1,200 persons, and discharges raw sewage into Twelvepole Creek below the water supply dam.

Small amounts of acid-mine wastes are discharged into tributaries of East Fork upstream from East Lynn. Although the quantity of such discharges is not considered large enough to seriously affect downstream water uses, an unusual incident did occur in the fall of 1959 when a coal mine was reactivated and an unusually large amount of acid water was discharged into the stream killing large numbers of fish.

WATER QUALITY

SURFACE WATER

The general quality of surface water in Twelvepole Creek is affected by fluctuations in stream flow--quality improvement being associated with higher flows.

Data obtained from analyses of samples collected by U. S. Geological Survey at low and high flows are tabulated below. Flows for the sampling dates were obtained from the U.S.G.S. gage at Wayne.

Location	Date of Sampling	Stream Flow (cfs)	Iron (ppm)*	Mn. (ppm)*	Total Hardness (ppm)*	pH
Dunlow, West Fork	Oct. 4, 1960	---	1.2	0.18	46	6.9
	May 2, 1961	---	0.26	0.18	20	6.3
East Lynn, East Fork	Oct. 4, 1960	---	1.5	0.26	140	4.25
	May 2, 1961	---	0.32	0.33	19	6.0
Wayne, Twelvepole Ck.	Oct. 4, 1960	3.5	1.3	1.4	57	6.2
	May 2, 1961	1880	0.62	0.92	22	6.3

* (ppm) parts per million

An investigation by the State water pollution control agency revealed that acid-mine drainage is discharged into Right Fork of East Fork of Twelvepole Creek upstream from East Lynn. In the vicinity of the proposed East Fork Reservoir the stream has a pH of 6.2, a total hardness of 22 ppm, and a total iron content of 0.8 ppm. Two miles below Wayne, Twelvepole Creek has a pH of 6.3, a total hardness of

32 ppm, and a total iron content of 0.7 ppm. During the investigation, average flow at the U.S.G.S. gage at Wayne was 352 cfs.

The data presented show that iron and manganese in East Fork, West Fork, and the main stem of Twelvepole Creek exist in concentrations which can cause problems associated with domestic uses if adequate treatment is not provided. Iron and manganese together should not exceed 0.3 ppm in water for domestic use.[1] Conventional treatment methods should successfully reduce to acceptable limits the concentrations found in Twelvepole Creek.

Information on bacteriological quality indicates that Twelvepole Creek at Wayne is satisfactory as a raw water source for domestic water supply. Water from the creek is currently utilized by Wayne and treatment produces a finished water of satisfactory quality containing about 30 ppm alkalinity, 75 ppm hardness, 0.1 ppm iron, 0.01 ppm manganese and pH of 8.8.

GROUND WATER

Analyses of water from four wells in the vicinity of Lavalette, West Virginia, (unincorporated community), made by the West Virginia State Department of Health indicated the following chemical quality:

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[1] U.S. Department of Health, Education, and Welfare, Public Health Service. Public Health Drinking Water Standards - 1946. Reprint No. 2697 from the Public Health Reports, Vol. 61, No. 11, March 15, 1946.

Well	Alkalinity (ppm)	Chloride (ppm)	Total Hardness (ppm)	Total Iron (ppm)	pH
(a)	240	8	202	0.2	7.7
(b)	155	4	210	1.4	7.1
(c)	477	322	42	0.2	8.2
(d)	48	5	80	1.4	6.7

An analysis by U.S.G.S. of water from a well drilled near Wayne gave 484 ppm alkalinity, 22 ppm chloride, 447 ppm hardness, 0.14 ppm iron, and approximately 1,000 ppm dissolved solids. This water would be considered of poor quality as a municipal source because of high dissolved solids and hardness.

PROPOSED WATER STORAGE

RESERVOIR SITES

Three sites are being considered for water storage reservoirs in Twelvepole Creek Basin. One site is located on Beech Fork approximately two miles southeast of Lavalette, West Virginia, 3.3 miles upstream from the mouth of Beech Fork. Another site is on East Fork approximately 1.3 miles south of East Lynn, West Virginia, 2.4 miles upstream from State Route 37 highway bridge at East Lynn. A third site is on West Fork, 32.5 miles above the mouth, 4.6 miles southeast of Missouri Branch, West Virginia.

LOW-FLOW AUGMENTATION

The three reservoirs under consideration offer several possible combinations for installation. Table 2 lists the proposed reservoirs, the drainage areas controlled, and the minimum flows which can be assured by seasonal and maximum water-storage pools. All possible combinations for the installation of these reservoirs are being considered by the Corps of Engineers to determine the most beneficial and feasible plan for the development and control of the water resources of the Basin.

TABLE 2

Proposed Low-Flow Augmentation

Reservoir	Drainage Area Controlled (sq. mil.)	Assured Minimum Flow (cfs)	
		Seasonal Pool	Maximum Pool
Beech Fork	78.2	14	27
East Fork	138.0	25	48
West Fork	40.1	7	14

Industrial development requiring significant quantities of water is not expected to occur within the Basin. The present trend of small commercial and residential development will probably continue. Expansion of industry is most likely to occur in the Huntington metropolitan area where facilities necessary for such expansion are currently available.

Development of the proposed reservoirs, particularly West Fork Reservoir adjacent to Cabwaylingo State Forest, would enhance recreational activities within the Basin. The sites are easily accessible from nearby population centers and water sports, such as fishing, boating, and swimming, would receive added impetus.

AUGMENTATION BENEFITS

AREAS CONSIDERED

As previously stated, Wayne is the only community within the Basin now utilizing surface water for domestic water supply and waste discharge purposes. Huntington has expressed an interest in obtaining a water supply of better quality, and would consider Twelvepole Creek as a potential source if a dependable flow of good quality water could be developed. The present water supply for Huntington is obtained from the Ohio River.

Kenova purchases water from the Catlettsburg, Kenova and Ceredo Water Company, Inc., Catlettsburg, Kentucky. Catlettsburg utilizes the Big Sandy River as a raw water source.

Ceredo formerly purchased water from the Catlettsburg, Kenova and Ceredo Water Company, but in recent years has developed its own source by installing three drilled wells.

WATER SUPPLY BENEFITS

1. General

Water supply benefits are calculated in terms of the costs of obtaining the same quantity and quality of water by the cheapest alternative means that would most likely be developed by the potential users in the absence of the Federal project. Considerations in the determination of water supply benefits included:

A. Single-purpose water supply reservoirs.

B. Development of ground water sources.

C. Savings in water treatment costs where existing ground water supplies can be replaced by surface water of good quality and adequate volume.

D. Savings in water treatment costs where an existing surface water source can be replaced by surface water of better quality.

The area in and adjacent to Twelvepole Creek Basin was investigated to determine water supply needs that could be satisfied by the addition of water storage in the proposed project.

Information furnished by the Corps of Engineers indicates that the normal pool elevation of the Ohio River, following completion of the Greenup Lock and Dam, will be 515 feet, and will extend up Twelvepole Creek a distance of approximately 8 miles from the mouth. In order for communities in the lower basin area to utilize Twelvepole Creek as a raw water source, it would be necessary for them to withdraw their water supply at some point above the normal Ohio River pool level.

2. Wayne, West Virginia

Wayne presently obtains its raw water from a small reservoir on Twelvepole Creek which provides an assured minimum flow of approximately 0.32 cfs. Projection of future water requirements indicates that the

present supply will be adequate until about 1990. Additional water would be needed after that time to provide a total of approximately 0.45 mgd (0.7 cfs) by the year 2015. A preliminary study indicates that the height of the existing dam cannot be raised for the purpose of increasing yield due to the possibility of flooding portions of the community.

The most feasible alternate source of dependable water supply for Wayne, in the absence of the proposed Federal project, is a single-purpose water supply reservoir. The most economical location for such a reservoir appears to be on East Fork of Twelvepole Creek 2.1 miles above its mouth. The estimated annual cost of the reservoir and, therefore, the annual water supply benefit is $8,330.[2] This cost is based on a project life of 50 years and includes operation, maintenance, and amortization at an interest rate of 4½ per cent.

3. Ceredo, West Virginia

Ceredo obtains its water from three drilled wells which are of such size and capacity that a sufficient quantity of water is available to meet estimated future requirements of the Town. Information obtained from the U. S. Geological Survey indicates that well-water supplies are practically unlimited in this area because of infiltration from the Big Sandy and Ohio Rivers. Ground water in the alluvium may be classified as moderately hard calcium bicarbonate water and with the

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[2] Developed by the Corps of Engineers, Huntington District, at the request of and in consultation with the Public Health Service.

exception of a relatively high iron content in some areas, the quality of this water is satisfactory for most purposes. Although the concentration of iron at Ceredo is higher than normally desired, it is not of serious concern to the community and iron removal is not practiced.

Since the Ceredo water supply is adequate for anticipated needs, the Town will not benefit from proposed water storage.

4. Catlettsburg, Kentucky

The private water company serving Catlettsburg and Kenova obtains its raw water from the Big Sandy River which has adequate flow to meet anticipated future requirements. On occasions during the past severe taste and odor problems have been experienced. In order to alleviate these problems, the company recently installed, at considerable expense, granulated activated carbon filter units. After three years of operation, the filters had been in use about 1,000 hours (4 per cent of the time) and were estimated to be only one-third exhausted. Company representatives feel that the carbon filters have overcome the taste and odor problem. Other experiences indicate that carbon filters used in conjunction with standard treatment facilities produce a water of excellent quality.

It is unlikely that the company will need to obtain a new raw water source within the foreseeable future; therefore, no water supply benefit will be derived from the proposed Federal project.

5. Kenova, West Virginia

Kenova purchases its water from the private water company in Catlettsburg, Kentucky; and, in turn, resells to local consumers. The company can provide an adequate supply of water of satisfactory quality which will meet anticipated future needs, including those of Kenova.

The community is situated in the area adjacent to the Big Sandy and Ohio Rivers where well-water supplies of satisfactory quality are believed to be practically unlimited. These well-water supplies offer a good alternate source of water supply for Kenova should the municipality decide to develop its own supply. By comparison, utilization of Twelvepole Creek would necessitate a long raw water transmission line in order to place the intake above the elevation of the Ohio River Greenup Pool. Because of the cost involved in transmission and treatment facilities and since the Town has an adequate supply of water of satisfactory quality, it is concluded that Kenova will not realize a water supply benefit from the proposed project.

6. Huntington, West Virginia

Evaluation of water supply benefits at Huntington will be based on the cheapest means of obtaining a satisfactory water supply in the absence of the proposed project. Since Huntington's present source of supply is not in the vicinity of the proposed Federal project, determination of the water supply benefit must include consideration of the cost of transporting water to Huntington.

The Ohio River serves as the raw water source for the Huntington Water Corporation and is sufficient in volume to meet all future needs. High pressure aeration and the application of activated carbon are employed in an effort to control a taste and odor problem. In 1960, the cost of this treatment was $68,300. Results, however, have not been entirely satisfactory and the Corporation has conducted tests to find a more effective means of control. These tests indicate that lesser amounts of activated carbon with longer contact periods would produce the desired result. Plans are being made to proceed with the construction of the necessary facilities. It is expected that the annual cost of such facilities, including reduced carbon feed, would approximately equal current costs of taste and odor control, but that a better quality water will be produced.

A projection of future water requirements indicates that approximately 22 mgd (33 cfs) will be needed by 1990, and by 2015 the needs will increase to 25 mgd (39 cfs). Based on these projected requirements and the current operation costs, the average annual cost for taste and odor control during the life of the proposed project will be $117,000.

Expansion of existing raw water pumping and transmission facilities will be required in order to meet future needs. It is estimated that the expansion, plus the operation and maintenance of the total intake facilities during the life of the proposed Federal project, will

result in an average annual cost of $72,000. Amortization of capital costs over a 50-year period at 4½ per cent is included in this figure.

The Huntington Water Corporation has expressed an interest in obtaining a water source having no taste and odor problem. The possibilities that exist include the development of a well system utilizing ground waters, or the development of another surface water source.

Information on ground water resources in the vicinity of Huntington indicates that wells in the alluvium can generally yield 100 to 200 gpm. When pumped at higher rates, the wells discharge fine sand and clay. Wells drilled through the alluvium and into the bedrock generally yield 50 gpm or less. Water in the bedrock is of satisfactory quality to a depth of several hundred feet; however, at greater depths it is salty and unfit for domestic uses. The Huntington Water Corporation has considered the possibility of utilizing ground water as a water source, but concluded that development of a well-water supply would be impractical because of the low yields anticipated and the extremely large well field that would be required. The Company formerly operated a separate water system for the Barboursville district, supplied by wells. The wells proved to be unreliable and the Huntington system was extended to serve the area.

It is concluded that ground water is not a feasible alternate source of supply for Huntington.

Other than the Ohio River, Twelvepole Creek provides the only surface water within a reasonable distance of Huntington which could be developed to provide a dependable supply of satisfactory quality water.

Iron and manganese concentrations in Twelvepole Creek and tributaries, although not unusually high, are great enough to be a potential water treatment problem. Chemical reactions and settling during storage tend to concentrate these minerals at the bottom levels of a reservoir. To minimize the concentrations of iron and manganese in a raw water supply obtained from a reservoir, provision should be made to allow withdrawal of water from the upper levels.

In order for Huntington to utilize Twelvepole Creek in the absence of the proposed project, it would be necessary to construct a single-purpose water supply reservoir. Preliminary investigation indicates the most probable location for such a structure is at the Corps of Engineers site near East Lynn. The estimated annual cost is $312,500, including construction, operation and maintenance, and amortization of 4½ per cent for 50 years.[3]

In addition to water storage facilities, utilization of Twelvepole Creek would require the construction and operation of a pipeline to transmit water from the source to Huntington. Consideration of terrain, extent of backwater from the Ohio River, and cost

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[3] Developed by the Corps of Engineers, Huntington District, at the request of and in consultation with the Public Health Service.

of construction, shows that a reasonable location for a water supply intake on Twelvepole Creek is approximately 14 miles upstream from the mouth. This places the intake at a location which would permit any combination of flow augmentation from the three proposed reservoirs and at an elevation of approximately 530 feet--15 feet above the pool of the Greenup Lock and Dam. Estimated average annual cost for intake structure, pipeline, pumping station, pumping equipment, operation, maintenance and amortization over a 50-year period at 4½ per cent interest is $263,000.[4] Since the estimated annual cost of utilizing the existing Ohio River intake is $72,000, the net annual cost that would be incurred in transmitting water from the proposed project is $191,000.

Annual savings in treatment required for taste and odor control have been estimated to be $117,000. The cost of transmission, therefore, would exceed the savings in water treatment, and Huntington would realize no monetary benefit from the proposed project.

Certain intangible benefits could be derived through utilization of water obtained from Twelvepole Creek. These benefits would be associated with the desire of the consumer for, and the satisfaction derived from, a taste- and odor-free water. A monetary value cannot be determined since it could only be measured by the amount the consumer is willing to pay.

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[4] Construction Cost Index of 840 (1913 = 100) was used. Engineering News Record, April 1961.

POLLUTION ABATEMENT BENEFITS

If a stream receives waste loads in excess of the maximum loading which can be assimilated under design low-flow conditions without reducing the dissolved oxygen content below an established objective, a pollution abatement benefit can be derived from augmented flows. This does not infer that low-flow augmentation would substitute for sewage treatment facilities required by State or local authorities. Augmented flow can, therefore, be considered as a valuable supplement to waste treatment facilities in solving pollution problems.

The stream flow used for the purpose of designing sewage treatment facilities in West Virginia is the minimum 7-day flow with a recurrence frequency of 10 years. The calculated design flow for Twelvepole Creek at Wayne is 0.1 cfs.

The minimum objective for dissolved oxygen in the stream is 4.0 ppm which is considered necessary in order to maintain the stream in satisfactory condition for downstream water users, to protect aquatic life and to prevent nuisance conditions.

At this time the State water pollution control agency is requiring a minimum of secondary treatment with chlorination of the treatment plant effluent in Twelvepole Creek Basin. Wayne, the location of the only significant waste discharge in the Basin, has

recently been notified that the Town will be required to provide such treatment.

Average water supply needs at Wayne exceed the design flow (0.1 cfs) and during periods at which this flow occurs, natural stream flow immediately below the Wayne dam is zero cfs.

Even with secondary treatment at Wayne, a minimum stream flow of 1.5 cfs would be required to assimilate the maximum anticipated waste load to be discharged and maintain a minimum dissolved oxygen content of 4.0 ppm.

Additional treatment above and beyond that normally included in secondary treatment plants could be employed to further reduce the organic pollution load to the stream in lieu of providing dilution water. For the average community, such treatment is outside the range of reasonable cost. Since Wayne is experiencing difficulty in financing secondary treatment facilities, provision of any additional treatment would impose an undue hardship on the community. It is, therefore, not anticipated that such treatment will be required.

The value of the necessary dilution water (1.5 cfs) can be measured indirectly in terms of the cost of additional treatment facilities. It is estimated that this water will have an average annual value of $4,300.